PATHOLOGY AND BACTERIOLOGY.

UNDER THE CHARGE OF
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Bacteriology of Pasteurized and Raw Milk.—AYERS and JOHNSON (*U. S. Department of Agriculture, Bureau of Animal Industry, Bull.*, 126) have studied the bacteriology of commercially pasteurized and raw market milk. In undertaking these studies they have deviated somewhat from the usual custom of isolating large numbers of individual strains or species of bacteria and then studying these in great detail. They have, on the contrary, approached the problem from the point of view of what the bacteria actually do in the milk, and they find that there are three principal types of bacterial activity represented—bacteria which form considerable amounts of lactic acid, bacteria which peptonize the milk, and finally, the third group, which produce a slightly alkaline reaction, but bring about no further change in the milk. They have summarized the advantages and objections to pasteurization as follows: The principal advantages are (1) protection from infection with the diseases usually transmitted by milk; (2) reduction of bacteria, and, as a consequence, of the infantile death rate; (3) improvement in the keeping quality of milk. The objections to pasteurization they have summarized as follows: (1) It is believed that the lactic acid bacteria in raw milk, which eventually sour the milk, exert a restraining influence on peptonizing bacteria which would otherwise cause putrefaction of milk. Peptonizing bacteria when freed from the restraining influence of the lactic acid organisms may increase to large numbers and produce toxins and poisonous decomposition products. (2) The pasteurization of dirty milk, while reducing the bacterial numbers, does not destroy the toxins or other products of bacterial growth. (3) Careless methods of handling milk for pasteurization may result in serious contaminations. (4) Pasteurization may be used simply to cover up dirty milk. It may encourage dirty methods in production and retard the extension of sanitary supervision. (5) Milk which has not been sold may be pasteurized or even re-pasteurized and its faults hidden. (6) Bacteria may increase more rapidly in pasteurized milk than in raw milk. (7) Undesirable changes may be produced by heating which result in making the milk less digestible, particularly in the case of infants. Ayers and Johnson conclude their paper as follows: (1) Commercially pasteurized milk always sours, because of the development of lactic-acid bacteria, which, on account of their high thermal death point, survive pasteurization, and perhaps in some cases, because of subsequent infection with acid-forming bacteria, during cooling and bottling. The acid development in an efficiently pasteurized milk is about the same as that in a clean raw milk. But sometimes a strong, old taste develops, which is probably due to the development of alkali or inert bacteria. The old taste, however, is not characteristic of pasteurized milk, for it may be noticed as well in clean raw milk when held under similar conditions. The less efficient the pasteurization process the more closely does the acid increase of the heated milk approach that of a dirty raw milk. (2) The relative proportion of the groups of peptonizing, lactic acid, and alkali or inert bacteria is approximately the same in efficiently pasteurized milk as it is in clean raw milk. In both cases the alkali or inert forms constitute the largest group, the lactic-acid bacteria next, while the peptonizers are in the minority. When both of these milks—the efficiently pasteurized and the clean raw milk—are held, the group relations change; but if the changes which take place are compared it will be found that they are the same in each. At the time of souring, the group proportions have changed so that the lactic-acid bacteria constitute the largest group, with the alkali or inert forms next in order, and the peptonizers in the smallest proportion as initially. In both of these milks the group of peptonizers may increase slightly in its proportion to the other two groups during the first two days, but it then gradually decreases and always forms the smallest group. When milk is less efficiently pasteurized the position of the groups may be reversed so that the lactic-acid bacteria constitute the largest group, with the alkali or inert forms next in order; but here again the peptonizers form the smallest proportion of the total bacteria. This group arrangement is the same in a dirty raw milk. The more efficient the pasteurization, the smaller the percentage of lactic-acid bacteria; and similarly, the cleaner the raw milk, the smaller the percentage of lactic-acid bacteria. (3) The peptonizing bacteria are present in smaller numbers in the inferior grades of commercially pasteurized milk during the first twenty-four hours after receiving than in raw milk of the same quality, and the peptonizers may increase to slightly higher numbers in the pasteurized milk when held several days than in the raw milk of high initial lactic-acid bacteria content; but it should be remembered in this connection that milk is usually consumed within twenty-four hours after delivery. The number of peptonizers in a good grade of commercial pasteurized milk on the initial count and on succeeding days is approximately the same as in a clean raw milk when held under similar temperature conditions. (4) Lactic-acid bacteria of high thermal death point are found in milk and may be easily isolated by special methods of procedure. From these experiments it was found that when milk is heated for thirty minutes at 60° C. (140° F.) and plated, the percentage of acid-forming organisms that resisted the heating ranged from 0.001 to 18.91, the average being 4.8 per cent. of the total acid colonies. When heated at 65.6° C. (150° F.) the range is from 0.001 to 3.13 per cent., the average being 0.74 per cent. of the total bacteria. It must be remembered that these figures are based upon acid colonies, and these are not necessarily all true lactic-acid bacteria. The thermal death point of one lactic-acid organism which was isolated from milk is 74.4° C. (166° F.) in broth and 75.6° C. (168° F.) in milk when heated in Sternberg bulbs for thirty minutes. When heated for ten minutes in milk the the rmal death point is 77.8° C. (172° F.). These heat-resisting lactic-acid bacteria play an important part in pasteurized milk and undoubtedly account to a large extent for its ultimate souring. (5) All milk, whether pasteurized or raw, must necessarily be infected during cooling and bottling, by bacteria in the receiving tanks, in the pipes, on the cooler, and in the bottles; but the low bacterial counts obtained from pasteurized milk in these investigations show that the reinfection must have been very small. (6) It is manifestly unfair to conclude that bacteria increase faster in pasteurized than in raw milk, simply from a comparison of the ratios of bacterial increase. If a pasteurized milk with a low initial count is compared with a raw milk of high bacterial content, then the ratios of increase may show that the bacteria in the heated milk do increase faster; but if the same pasteurized milk is compared with a clean raw milk with a low count, then the ratios of increase will be found to be approximately the same. From the results of this investigation it is evident that bacterial increase in an efficiently pasteurized and a clean raw milk is about the same when the samples of milk are held under similar temperature conditions. This question of the relative growth of bacteria in raw and pasteurized milk can be properly settled only by a long series of comparisons of samples of milk with approximately the same bacterial count and similar bacterial group percentages. (7) The "holder" process of pasteurization is superior to the "flash" process. With the "holder" process a high efficiency may be obtained with a low temperature, while to obtain the same efficiency with the "flash" process a high temperature would be required. A temperature of 62.8° C. (145° F.) for thirty minutes seems best adapted for efficient pasteurization. (8) Considering the low counts of bottled commercially pasteurized milk and the similarity of the bacterial group proportions to those of clean raw milk, the former cannot be classed from a bacteriological point of view as inferior to commercial raw milk. Pasteurized and raw milk should, however, always be bottled, and should not be allowed to be sold as "loose" milk from stores. (9) Pasteurization should always be under the control of competent men who understand the scientific side of the problem. It is believed that ignorance of fundamental bacteriological facts often accounts for inefficient results rather than a willful lack of care on the part of the dairyman.

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